Field Observation of the Biotic Factors Regulating the Population of the Armyworm, Pseudaletia unipuncta (Haworth)[1]

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During the period from March to May, 1965, the armyworm *Pseudaletia unipuncta* (Haworth) population on the Kahua Ranch, Kohala, Hawaii, was kept under close observation for studying the role of the biotic factors, especially the pathogens, in the regulation of its populations. In previous studies (Tanada, 1961, 1962), the armyworm appeared regularly in large numbers during the spring months on this ranch, and a nuclear-polyhedrosis and a granulosis virus, and a microsporidian were found important in controlling the armyworm. In this study, the armyworm population did not increase to significant levels and at this low host density, the insect parasites appeared dominant in maintaining the population of the armyworm. Although the present observation is limited, it provides interesting data on the persistence of pathogens at a low host level, and a record of a virus previously unreported from Hawaii.

MATERIALS AND METHODS

The study was conducted in three areas (Stations 2, 3, & 6) established in 1958 on the Kahua Ranch (Tanada, 1961). The armyworm population failed to build up in other areas. The Kikuyu grass, *Pennisetum clandestinum* Hochst., is the principal range grass on this ranch.

The methods of host population sampling and of determining disease incidence have been described (Tanada, 1961). Three plots, 25 sq. ft. each, were set up in each station. The plots were about 20–30 yards apart and roughly arranged at the points of an isosceles triangle.

The armyworm population at each station was ascertained weekly by two methods: (1) number of larvae and pupae found within 5 areas (selected at random within the station plot) of 1 sq. ft. each of range turf, and (2) number collected with a D-Vac sampler (Dietrick, 1961) from five 1-square-foot areas located outside and adjacent to each plot (three of the 1-square-foot samples were collected adjacent to three sides of the plots and two from the fourth side). The D-Vac sampler was used for the first time this year.

The determinations of the incidences of insect parasitization and microbial infection were based on two methods. In the first, the number

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of larvae on the turf surface was counted while pacing twice over the three plots, with the two pacings at right angles to each other. Larvae infected with nuclear polyhedrosis and granulosis usually emerged to the surface and died hanging from the grass blades. The dead and moribund larvae were placed individually in 1 or 2-dram screwcap vials. Internal contents of the larvae were examined with the light microscope usually within 24 hours. Most cases diagnosed as a virus infection were later confirmed with the electron microscope.

The second method utilized the larvae collected with the D-Vac sampler from each plot. Larvae in the third or older instar were dissected and a portion of their midguts and internal contents examined with the light microscope. Since very few larvae were collected by the first method, the second method presented a more accurate evaluation of insect parasitization and microbial infection.

The incidences of diseases and insect parasitization were observed three times each week with the first method and once a week by the second method.

RESULTS

Daily temperatures ranged from a minimum of 49 °F (9.4 °C) to a maximum of 88 °F (31.1 °C) with an average of 66.0 °F (18.9 °C). The daily relative humidity ranged from a minimum of 34.0% and a maximum of 100% with an average of 80.1%. Nearly every night 100% R.H. was reached during certain periods.

The D-Vac sampler provided a more accurate estimate of the larval armyworm population than the visual counts (Fig. 1). Both methods, however, presented similar trends in population fluctuations.

Unlike the situations in 1958 and 1960 (Tanada, 1961), the armyworm population failed to increase to high numbers during the spring months. In Stations 2 and 3, fluctuations in populations were similar (Fig. 1). The peaks in larval populations in Stations 2 and 3 occurred between 20, IV and 11, V. These stations were about 300 yards apart and were separated from Station 6 by a minimum of 1,500 yards. Station 6, on the other hand, showed a slight rise in population in the D-Vac sample between 20–26, IV.

Closely associated with the increase in larval population was the marked increase in the incidence of biotic agents. Insect parasites were more prominent than the pathogens (Table 1). Moreover, since the armyworm larvae were killed and dissected prior to their natural death or development in order to establish microbial infection, the estimate of incidence of biotic agents was probably lower than if these larvae were left exposed to parasites and pathogens in the field.

Since the diagnostic method also prevented accurate identification of the insect parasites in egg and larval stages, a small sample of field-collected armyworm larvae was reared until the parasite emerged. The insect

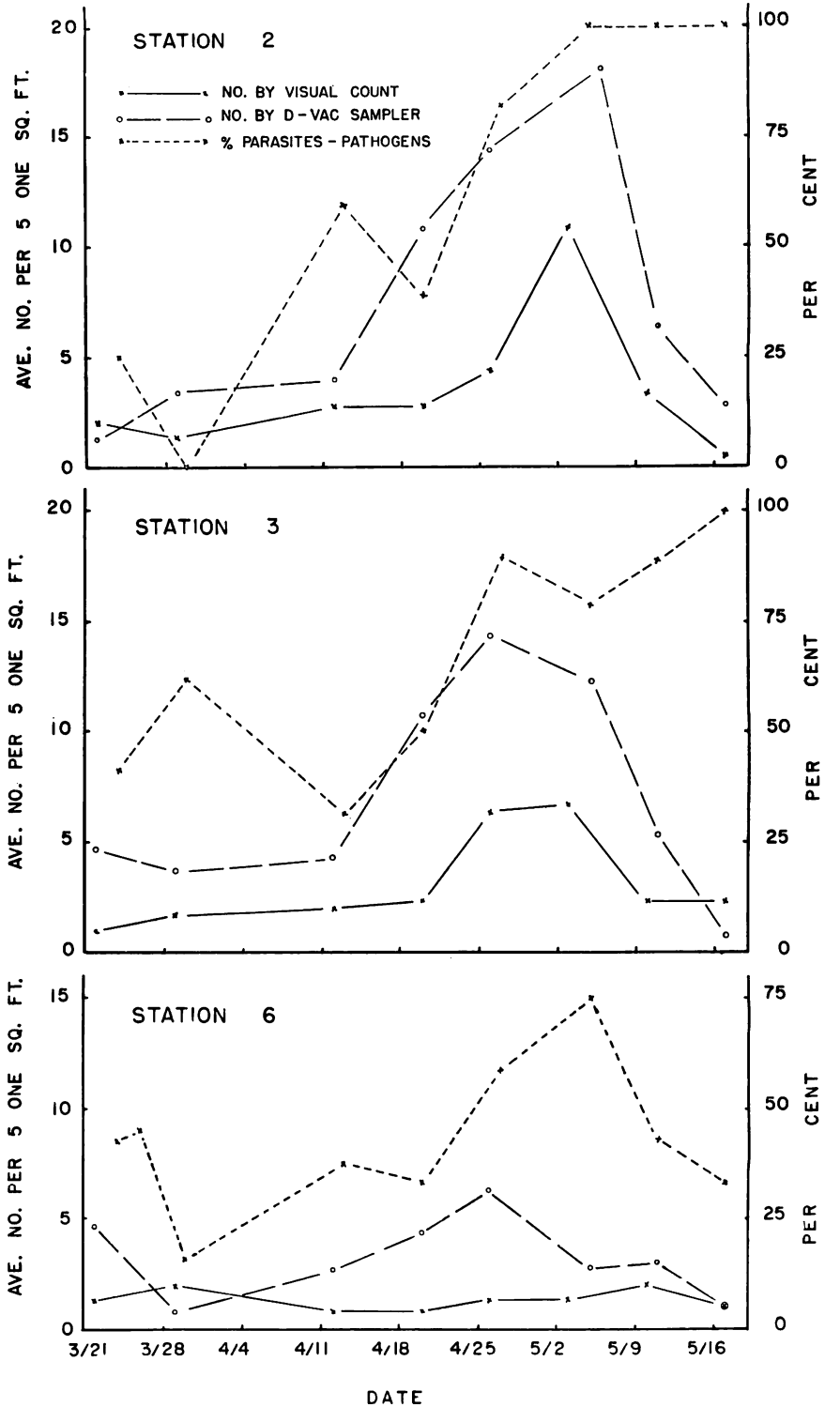

Fig. 1. Fluctuations in the armyworm population and in the incidence of biotic agents in three stations located at the Kahua Ranch, Kohala, Hawaii during March to May, 1965.

Table 1. Incidences of insect parasitization and microbial infection in armyworm larvae collected in the field with the D-Vac sampler. The figures represent the number of larvae collected from three plots at each station.

Station	Date	No. examined	Number with						
			Cytoplasmic polyhedrosis a/	Cytoplasmic polyhedrosis + parasites	Microsporidia b/	Microsporidia + parasites	Fungi c/	Parasites d/	No. healthy
2	3—17	6	1					1	4
	3—24	4						1	3
	3—30	2							2
	4—13	12	1	1				5	5
	4—20	11		1				3	7
	4—27	23	2	5				12	4
	5— 5	23	1	8				14	
	5—11	11	1	5		1		4	
	5—17	5		3				2	
Total		97	6	23		1		42	25
3	3—17	3			1			2	
	3—24	12			1			4	7
	3—30	8			1			4	3
	4—13	12						4	8
	4—20	14	4	3					7
	4—27	18		3				13	2
	5— 5	18	3	2				9	4
	5—11	8		2	1			4	1
	5—17	1		1					
Total		94	7	11	4			40	32

—— continued ——

Table 1 (Cont.). Incidences of insect parasitization and microbial infection in armyworm larvae collected in the field with the D-Vac sampler. The figures represent the number of larvae collected from three plots at each station.

Station	Date	No. examined	Number with						
			Cytoplasmic polyhedrosis a/	Cytoplasmic polyhedrosis + parasites	Microsporidia b/	Microsporidia + parasites	Fungi c/	Parasites d/	No. healthy
6	3—20	10			1		1	2	6
	3—24	14						6	8
	3—26	11			1			4	6
	3—30	6						1	5
	4—13	8			1	1		1	5
	4—20	9						3	6
	4—27	11						7	4
	5— 5	8						6	2
	5—11	7						3	4
	5—17	3						1	2
Total		87			3	1	1	34	48

a/ A cytoplasmic-polyhedrosis virus

b/ Probably two species of microsporidians in the genera, *Nosema* and *Thelohania*

c/ *Beauveria bassiana*

d/ Predominantly *Apanteles militaris*, *Apanteles* sp. prob. *marginiventris*, *Meteorus laphygmae*, and *Eucelatoria armigera*

parasites obtained were *Apanteles militaris* Walsh, *Apanteles* sp. probably *marginiventris* Cresson, *Meteorus laphygmae* Viereck and *Eucelatoria armigera* (Coquillet)[2]. In addition to these, other Hymenoptera and Diptera (e. g., *Archytas cirphis* Curran) commonly associated with noctuids were seen in the field.

The presence of hymenopterous and dipterous parasites had a distinct hemotropic effect in the armyworm larvae. An apparent hemocyte showed marked hypertrophy. Since this hemotropic effect was observed consistently only in parasitized larvae, it may serve as an important sign for rapid diagnosis of parasite infestation in these larvae. The identification of the blood cell and the basis for its hypertrophy are being investigated.

The pathogens observed were a cytoplasmic-polyhedrosis virus, a microsporidian, a nuclear-polyhedrosis virus and a fungus (*Beauveria bassiana* [Balsamo] Vuillemin). A single laboratory test failed to establish the pathogenicity of this fungus for the armyworm, and the test should be repeated. In our previous studies, the nuclear polyhedrosis and the granulosis were the predominant diseases in the field. In the present study, there were only 5 larvae with nuclear polyhedrosis and none with granulosis.

DISCUSSION

The observations of this study have confirmed those of the previous years that biotic factors are important in regulating field populations of the armyworm in Hawaii. In the earlier studies, nuclear-polyhedrosis and granulosis viruses played major roles in controlling the armyworm. In this study, with a very low armyworm population, the insect parasites, however, were more prominent, and the pathogens appeared to play a minor role. The most common pathogens were a cytoplasmic-polyhedrosis virus and a microsporidian. The granulosis virus was not observed, but the nuclear-polyhedrosis virus persisted in the low armyworm population.

In many instances a single host larva was afflicted simultaneously by a pathogen and an insect parasite. The pathogens most frequently found in such associations were the cytoplasmic-polyhedrosis virus, and, occasionally, the microsporidian.

This is the first record of a cytoplasmic-polyhedrosis virus, the third virus in field populations of the armyworm in Hawaii. The virus, may have been present in Hawaii for many years, since no special attempt was made to look for it in our previous studies. The virus is apparently identical to the one discovered in a laboratory culture in California (Tanada & Leutenegger, 1965).

SUMMARY

In the spring of 1965, the population of the armyworm, *Pseudaletia uni-*

[2]I wish to express grateful appreciation to Dr. J.W. Beardsley and Dr. D.E. Hardy, Department of Entomology, University of Hawaii, for their assistance in identifying the parasites.

puncta, was unusually low at the Kahua Ranch, Kohala, Hawaii. The biotic factors (parasites and pathogens) were apparently effective in regulating the armyworm population. The pathogens, two viruses, and a microsporidian persisted under the low host population. The insect parasites provoked a hemotropic effect in the larvae.

A cytoplasmic-polyhedrosis virus and probably the fungus, *Beauveria bassiana*, are reported for the first time from the armyworm in Hawaii.

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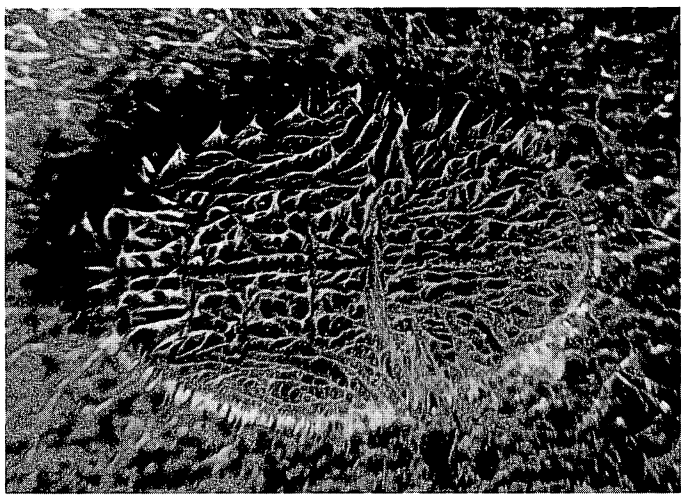
Notes on Swezeyana (Psyllidae: Homoptera)

L. D. Tuthill

A mixed population of *Swezeyana elongagena* Caldwell and *S. reticulata* Caldwell on a *Siderozylon* tree at Awahi, Maui, was discovered by Beardsley on 4, III. 65. The only previous collection known is the type series. (Proc. Haw. Ent. Soc. 10 (3):390).

Nymphs of both species were abundant, chiefly on the upper surface of the leaves. However, those on the underside appeared to thrive as well. The occurrence of the two distinct species in the same ecological niche is unusual. Both species were fed upon by larvae of *Chrysopa* sp. and a syrphid fly. Adults feeding demonstrated little tendency to escape when disturbed. Adults were reared easily in the laboratory.

Nymphs are distinct from other psyllids and from one another. In all instars, *S. elongagena* is covered with a definitely patterned mesh of wax filaments. Although they arise from many pores, they are fused (Figure).



The nymphs of reticulata display no wax filaments and have a remarkable armament of large proturberances on the dorsal surface.